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The identification of neurologically relevant items in the MMPI-2

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The assessment of personality and (mal)adjustment after brain damage is regarded as an important aspect of rehabilitation. However, the administration of widely used self-report questionnaires, such as the Minnesota Multiphasic Personality Inventory-2 (MMPI-2), is restricted because of the danger of overscoring psychopathology and personality disorders. This is due to the inclusion of items reflecting manifestations of neurological dysfunction. Earlier investigations revealed variable neurologically relevant items (NRIs), within and between discrete cerebral aetiologies for the MMPI as well as the first part of the MMPI-2. In this study, 10 neuropsychologists, 10 neurologists, 10 psychiatrists, and 10 physiatrists identified NRIs in the complete MMPI-2. An item was considered to be an NRI based on professional expertise as well as type of brain damage. Based on a substantial inter-rater agreement index, four sets of clinical relevant NRIs were selected: one for brain damage in general and three partially overlapping sets for stroke, traumatic brain damage, and whiplash. Thus, the findings of this study unveil items which may indicate *bona fide* symptoms or manifestations related to neurological damage or dysfunction, rather than just reflecting psychopathology or personality disorders. It is advocated to develop an interpretative approach to correct for the impact of these NRIs on MMPI-2 scores.

Die Identifikation neurologisch relevanter Items im MMPI-2

Das Assessment der Persönlichkeit und (Fehl-)Anpassung nach Hirnschaden gilt als wichtiger Aspekt der Rehabilitation. Jedoch ist der Einsatz gängiger Selbstberichtfragebogen, wie des Minnesota Multiphasic Personality Inventory-2 (MMPI-2), wegen der Gefahr einer Überbewertung von psychopathologischen Symptomen und Persönlichkeitsstörungen nur eingeschränkt möglich. Dieses Risiko ist auf den Einbezug von items zurückzuführen, die Manifestationen neurologischer Funktionsstörungen widerspiegeln. Frühere Untersuchungen erbrachten für den MMPI wie auch den ersten Teil des MMPI-2 variable neurologisch relevante Items (NRIs), sowohl innerhalb als auch zwischen einzelnen zerebralen Ätiologien. In der vorliegenden Studie wurden im gesamten MMPI-2 von jeweils 10 Neuropsychologen, Neurologen, Psychiatern und Physiatern (Ärzte für physikalische und rehabilitative Medizin) derartige NRIs identifiziert, wobei die Einstufung als neurologisch relevantes Item auf der jeweiligen fachlichen Einschätzung sowie der Art des Hirnschadens basierte. Vier Gruppen klinisch relevanter NRIs wurden ausgewählt: eine für Hirntrauma allgemein und drei teilweise überlappende Gruppen für Schlaganfall, traumatischen Hirnschaden und Schleudertrauma. Die Ergebnisse dieser Studie machen folglich items sichtbar, die eher auf Bona-fide-Symptome oder

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-Manifestationen in Zusammenhang mit neurologischen Schäden bzw. Funktionsstörungen hindeuten, also nicht bloß psychopathologische Sachverhalte oder Persönlichkeitsstörungen widerspiegeln. Die Autoren befürworten die Entwicklung eines interpretativen Ansatzes, der geeignet ist, den Einfluß dieser NRIs auf die MMPI-2-Scores auszugleichen.

L'identification des questions neurologiquement significatives dans le MMPI-2

L'évaluation de la personnalité et de l'(in)adaptation après la constatation des lésions cérébrales peut être considérée comme un aspect important de la réhabilitation. Cependant, peu de questionnaires d'auto-évaluation, largement utilisés par ailleurs, tel que l 'Inventaire de Personnalité Multiphasique de Minnesota (MMPI-2 The Minnesota Multiphasic Personality Inventory) sont employés étant donné le risque de surestimation des troubles de la personnalité et de la psychopathologie. Ceci est attribuable à la présence de questions impliquant les manifestations des dysfonctionnements neurologiques. Les enquêtes précédentes ont révélé diverses questions neurologiquement significatives (QNS – NRINeurologically Relevant Items) à l'intérieur et entre les étiologies cérébrales discrètes en ce qui concerne le IPMM (MMPI) et également dans la première partie du IPMM-2 (MMPI-2).

Dans cette étude dix neuropsychologues, dix neurologues, dix specialistes en medicine de la rehabilitation et dix psychiatres ont relevé les (QNS – NRI) dans l'ensemble du IPMM-2 (MMPI-2) La classification en QNS (NRI) était basée sur les connaissances professionnelles des quarante membres de l'équipe et également sur le type de la lésion cérébrale. Quatre groupes de QNS (NRI) cliniquement significatives ont été identifiés, l'un général, couvrant l'ensemble des lésions cérébrales et trois se recoupant partiellement, concernant les attaques cérébrales, les traumatismes crâniens et le syndrome cervical traumatique. Ainsi, les résultats de cette étude dévoilent les questions qui peuvent révéler de symptômes ou des manifestations fiables, indicatifs d'une lésion ou d'une dysfonction neurologique, plutôt que de seulement indiquer une psychopathologie ou des troubles de la personnalité. Il est souhaitable qu'une approche interprétative soit adoptée à l'égard de ces QNS(NRI) et corrige ainsi leur influence sur les résultats du IPMM2(MMPI-2).

La identificación de apartados de interés neurológico en el MMPI-2 (Inventario Multifásico de Personalidad de Minessota-2).

La valoración de la personalidad y de la (mal)adaptación tras la lesión cerebral se considera un aspecto importante de la rehabilitación. No obstante, la aplicación de cuestionarios autodescriptivos ampliamente utilizados, como el Inventario Multifásico de Personalidad de Minnessota-2 (IMPM-2), está sujeta a limitaciones, a causa del riesgo de sobrevalorar los trastornos psicopatológicos y de la personalidad. Esto se debe a la introducción de apartados que reflejan manifestaciones de alguna disfunción neurológica. Anteriores investigaciones habían revelado que Apartados Neurológicamente Relevantes (ANRs), tanto en el IMPM como también en la primera parte del IMPM-2, dentro de y entre etiologías cerebrales determinadas. En el presente estudio, 10 neuropsicólogos, 10 neurólogos, 10 psiquiatras y 10 rehabilitadores identificaron ANRs en el IMPM-2tomado en su totalidad. Un apartado venía a considerarse como ANR en base a la experiencia profesional así como al tipo de lesión cerebral. Se seleccionaron cuatro conjuntos de ANRs clínicamente relevantes: uno para la lesión cerebral en general y tres, que se solapaban parcialmente, para el derrame cerebral, la lesión cerebral traumática y el efecto de latigazo. Además, los hallazgos del estudio desvelan que algunos apartados pueden indicar síntomas fiables de manifestaciones relacionadas con la lesión neurológica o con la disfunción, en vez de sólo reflejar trastornos psicopatológicos o de la personalidad. Se aboga por el desarrollo de un enfoque interpretativo que corrija el impacto de estos ANRs en los resultados de la IMPM-2.

Keywords: brain damage; personality assessment; psychopathology; psychosocial functioning; rehabilitation

Introduction

This article deals with the identification and selection of neurologically relevant items in a self-report questionnaire, the Minnesota Multiphasic Personality Inventory-2, the MMPI-2 (Butcher *et al.*, 1989). It is aimed at facilitating a valid evaluation of personality, adjustment and emotional status after brain damage in general and in particular after stroke, traumatic brain damage, and whiplash (flexion–extension injury of the cervical spine).

The assessment of personality and personal adjustment after brain damage is regarded as an important aspect of (neuro)psychological rehabilitation. To be able to evaluate the patient's skills and performance, information is needed about the extent to which emotional state, motivation and characterological predispositions may influence the patient's behaviour. Often, this information is acquired by self-report tests of personality and emotional status, such as the Symptom Check List-90-R (Derogatis, 1983), the Beck Depression Inventory (Beck, 1987), and the MMPI-2 (Butcher *et al.*, 1989).

Although these inventories are widely used, they have some practical limitations. For example, due to cognitive and sensorimotor impairments, brain-damaged patients may manifest a restricted capacity in taking such a paper-and-pencil test as the MMPI-2. A more important danger lies in the overscoring of psychopathology, mood disorders, and personality disorders for *brain*-damaged patients who actually complete such questionnaires (Gass, 1991; Lezak, 1995). With regard to the MMPI-2, the risk of overscoring psychopathology is grounded in the method of test construction: Using a criterion-keyed methodology, items were selected that effectively discriminated between a normal and a *psychiatric* population (Greene, 1991; Graham, 1993). This was done regardless of item's possible association with neurological problems that are unrelated to psychopathology or personality disorders. Indeed, several authors (e.g. Chelune and Moehler, 1986; Prigatano, 1987; Coughlan and Storey, 1988; Gass and Russell, 1991; Gass and Lawhorn, 1991; Woessner and Caplan, 1995) describe items which seem to reflect the sequelae of neurological pathology instead of psychological functioning. These items concern issues such as attention and concentration deficits, memory problems, headache, dizziness, visual disorders, paralysis, and motor impairments. For example, it is often justifiable to interpret an affirmative response of a brain-damaged patient to item 31, 'I find it hard to keep my mind on a task or job', as a manifestation of an attentional disorder. As a consequence, the endorsement of this and similar items is liable to give false positive results on scales and subscales that include these neurologically relevant items, so-called NRIs (Gass and Russell, 1991).

The problem of a suspected inflation of test scores may be solved in three ways. Firstly, self-rating scales may be developed that address only feelings and avoid enquiries about somatic symptoms, cognitive deficits and the ability to participate in former activities. The 30-item Wimbledon Self-Report Scale (WSRS) (Coughlan and Storey, 1988) is an example of such a scale, and is developed to appraise emotional state and mood disturbances in people with neurological illness. Although it is not exceptional to use

unidimensional measurements such as the WSRS, psychological problems after brain damage are to diverse to justify reliance upon narrowly focused test instruments.

Secondly, the experienced clinician may estimate the impact of neurologic symptoms and accordingly adjust elevated scores on questionnaires. However, such a procedure is not standardized and a great inter-observer variance would be expected. This obviously afflicts the reliability and validity of the questionnaires in the before-mentioned populations.

Thirdly, an interpretative strategy may be developed in order to correct the impact of NRIs. This has been done for widely used instruments, such as the SCL-90-R (Woessner and Caplan, 1995), the MMPI (Alfano *et al.*, 1990; Gass and Lawhorn, 1991; Gass and Russell, 1991; Alfano *et al.*, 1993), and, partially, for the MMPI-2 (Gass, 1991; 1992).

All of the above strategies have a common characteristic of correcting for items which could potentially expose valid symptoms or manifestations of neurologic damage or dysfunction. The third option, an adjusted interpretative strategy for current instruments, seems highly attractive because it preserves the application of empirical knowledge and clinical experience accumulated by such instruments. However, for the MMPI (-2), the number of selected NRIs varies across studies, ranging from 14 to 44 items (Alfano *et al.*, 1990, 1993; Gass, 1991, 1992; Gass and Lawhorn, 1991; Gass and Russell, 1991). Furthermore, distinctive selection procedures reveal different NRIs for the same aetiological categories (e.g. Alfano *et al.*, 1990; Gass, 1991; Gass and Russell, 1991), and similar selection methods produce dissimilar NRIs for discrete cerebral aetiologies (e.g. Gass 1991, 1992; Gass and Lawhorn, 1991). Also, the MMPI-2 has not yet been used in his original form (Gass, 1992; Gass and Lawhorn, 1991).

The question is whether the kind of selection procedure or the type of brain damage must be held responsible for the discrepancies in it ems selected as NRIs, but what is evident is that at the moment it is unsafe to rely on earlier results when correcting for the impact of neurologically relevant items in the MMPI-2.

The primary objective of the present study was to identify NRIs for the complete 567 item pool of the MMPI-2. In addition, we wanted to investigate whether the selected NRIs were independent of the type of brain damage. This is of relevance because if this were the case, the use of one sole corrective interpretative approach for all brain-damaged patients would be justified. In accordance with earlier studies, the present investigation focused on two major diagnostic categories, as defined by incidence rates, namely, traumatic brain injury and stroke (e.g. Van Balen *et al.*, 1996). Whiplash was included as a third diagnostic category, which is important not only in terms of incidence rate but also because of controversies about etiological, clinical and forensic matters (e.g., Sweeney, 1992; Miller, 1996; Radanov and Dvorak, 1996).

In addition, since the reliance on only a few specialists of one profession could possibly result in personal and professional preferences, it was thought sensible to investigate whether the professional background of the expert is a relevant variable in identifying NRIs.

Material and methods

Subjects

Forty experts (10 neuropsychologists, 10 neurologists, 10 psychiatrists, and 10 physiatrists) were invited and agreed to participate in this study. All experts were certified in their respective specialty area.

These experts, all familiar with brain-damaged patients, were asked for their opinion on NRIs. It was assumed that NRIs uncovered by representatives of more than one profession would be more valid than NRIs identified by only one type of expert. Moreover, by consulting specialists of different professional backgrounds, it is possible to investigate whether the profession of the expert is a relevant factor in identifying NRIs.

Material

The MMPI-2 has been translated, normalized and standardized for Belgium and the Netherlands (Derksen *et al.*, 1995). All specialists were requested to examine the booklet form of the Dutch translation of the standard 567-item version of the MMPI-2 (Sloore *et al.*, 1993).

Procedure

We asked the experts 'to imagine patients with diseases of the central nervous system in general and subsequently to identify the items of the questionnaire that, in their opinion, reflected possible symptoms or manifestations of neurological damage or dysfunction'. This question was repeated for patients with traumatic brain damage, stroke, and whiplash. Thus, all raters examined the 567 items of the MMPI-2 for four patient groups. An item was scored 1 if it was regarded as an NRI, and 0 if it was considered a non-NRI.

The following procedure was conducted to identify and select NRIs. Preliminary analyses investigated overall effects with respect to inter-rater agreement and frequencies of NRI endorsement for all MMPI-2 items. We investigated whether considering an item as an NRI was dependent on patient group, expert group or an interaction between these two. The overall effects warranted further steps.

First, items were identified that could be considered as NRIs or non-NRIs without additional analysis; these items had an inter-rater agreement percentage of at least 70% over all 40 experts. Secondly, unweighed group kappa coefficients were calculated for all remaining items that had a lower inter-rater agreement in either direction, NRI or non-NRI. Thirdly, of these, items were identified and selected as an NRI with a mean inter-rater agreement of 70% or more for at least two expert groups. Steps one to three were repeated for all patient groups. Fourthly, those NRIs were identified which would be of relevance with respect to their potential influence on scaled MMPI-2 scores if endorsed in the scored direction ('true' or 'false'), and which were the involved MMPI-2 scales for these items. Finally, as a result of this stepwise procedure, four sets of clinical relevant NRIs for different neurological patient groups were selected.

Statistical analysis

Data sets were evaluated by multivariate analysis of variance (MANOVA), inter-rater reliability measures, and Poppings' AGREE procedure, which is a modification of Cohens' kappa (1960). The latter method has been developed for the assessment of agreement among more than two raters.

Results

In order to investigate whether considering an item as an NRI is dependent on patient group (brain damage, stroke, traumatic brain injury, whiplash), expert profession

(neuropsychologists, neurologists, psychiatrists, and physiatrists), or an interaction between these two factors, NRI endorsement frequencies were calculated for each item per expert profession. Thus, for each item the endorsement frequencies per expert profession ranged from zero to 10. This was carried out for each patient group. A two-factorial MANOVA, with mean frequency of NRI endorsement over all items as the dependent variable and Expert profession (neuropsychologists, neurologists, psychiatrists, and physiatrists) and Patient group (brain damage, stroke, traumatic brain injury, whiplash) as the factors, revealed significant main effects for Expert profession: ($F(3,2264) = 22.93$, $P < 0.000$); Patient group: ($F(3,6792) = 256.72$, $P < 0.000$), as well as a significant interaction ($F(3,9) = 6.47$, $P < 0.000$).

Figure 1 shows the mean NRI endorsement over all 567 MMPI-2 items for each expert profession for each patient group. For each expert profession, physiatrists and neuropsychologists on the one hand showed significantly higher levels of NRI endorsement than neurologists and psychiatrists on the other, being highest for physiatrists ($M = 1.52$, $SD = 2.42$), followed by neuropsychologists $M = 1.40$, $SD = 2.22$), neurologists ($M = 0.85$, $SD = 1.60$), and psychiatrists ($M = 0.81$, $SD = 1.60$).

The frequency of NRI endorsement over all expert professions is highest for brain damage in general ($M = 1.49$, $SD = 2.35$), followed by traumatic brain damage ($M = 1.18$, $SD = 1.99$), stroke ($M = 1.06$, $SD = 1.87$), and whiplash ($M = 0.86$, $SD = 1.75$). This rank order is the same for all expert professions. Obviously, these low values for mean NRI endorsements demonstrate that the majority of the MMPI-2 items are non-NRIs.

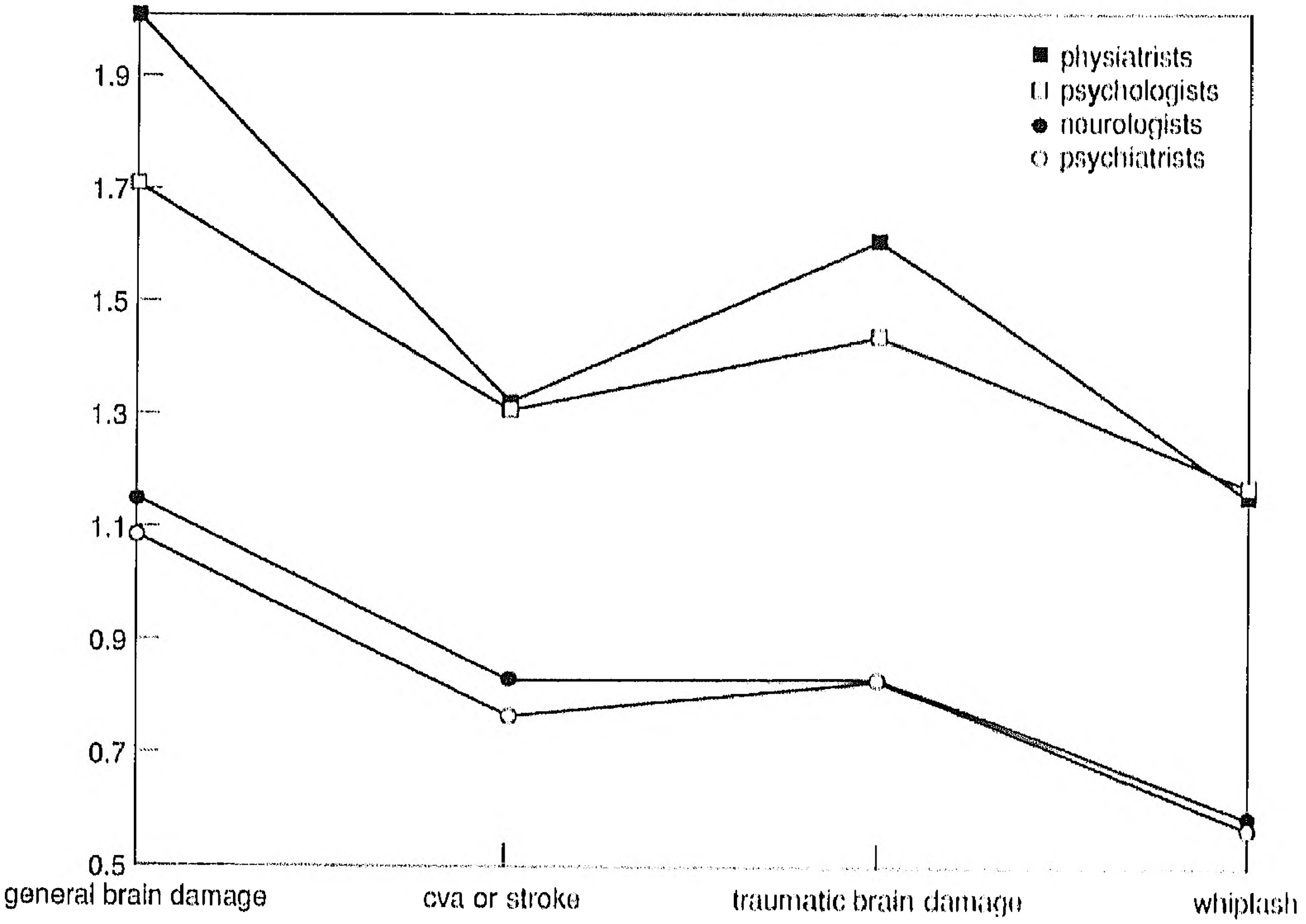

Fig. 1. Mean endorsement frequencies over all MMPI-2 items (*y* axis) for patient groups and expert profession groups (*x* axis).

The preliminary analyses above warranted further study to consider the differences in NRI item endorsement between expert professions, and to identify the NRIs for each patient group.

Initially, items were identified that could be considered as NRIs or non-NRIs by accomplishing an inter-rater agreement percentage of at least 70% over all experts ($n=40$) within that patient group. This is regarded as a 'substantial' inter-rater agreement. Although this index ignores chance agreement, it is a clearly interpretable measure of reliability because, within 40 raters, a 70% agreement can hardly be due to chance ($P<0.0000$). For brain damage in general, the majority of expert professionals rated the following 33 items as NRIs: 10, 23, 31, 40, 53, 57, 93, 101, 106, 116, 146, 147, 149, 164, 165, 176, 177, 179, 180, 182, 213, 247, 255, 295, 308, 325, 341, 464, 472, 475, 525, 533, and 565. Thus, for these items, at least 28 out of 40 raters identified them as possible symptoms or manifestations of neurological damage or dysfunction in general. However, employing this index for stroke, traumatic brain damage, and whiplash, the number of NRIs was 14, 13, and 6, respectively.

Apparently, several items which could be selected as either NRI or non-NRI remain which have a lower inter-rater agreement. For each patient group, this number is different: brain damage in general, 133; stroke, 92; traumatic brain damage, 116; and whiplash, 83. For these items, the unweighed group kappa coefficients were calculated for each expert profession, ranging from 0.0975 to 0.1862. This reflects only a slight inter-rater agreement for all expert professions, regardless the kind of brain dysfunction, and suggesting a substantial variation in inter-rater agreement for these remaining items. Therefore, in the next step, items were identified which achieved an inter-rater agreement percentage of at least 70% for at least two expert groups for brain damage in general. These items were: 3, 18, 38, 39, 45, 91, 141, 152, 168, 173, 224, 229, 249, 252, 299, 309, 404, 444, 476, 536, and 561 ($n=21$). Thus, a total of 54 items (33+21) were identified for the patient group 'brain damage in general' which could be considered as neurologically relevant for brain damage in general. See the Appendix for the content of these items and the scored direction.

Since preliminary investigation revealed that considering an item as an NRI may be dependent on patient group as well as on expert opinion, a two-factorial MANOVA with difference contrasts was conducted on each of the 54 items mentioned in the Appendix to explore main effects of patient group in the pattern of frequency of NRI endorsement. The Pillais multivariate test of significance for the interaction was non-significant for all these items but one (item 252, $P=0.036$). Thus, on the whole, expert profession by patient group interaction effects were absent. In addition, significant patient group effects can be observed for all items, with the exception of the items 10, 141, and 152. Significant expert profession effects are revealed for 11 items: 3, 39, 93, 141, 165, 180, 229, 252, 309, 444, and 475. Thus, patient group seems to determine the inclusion of an item as an NRI more often than the interpretation of relevance based on the professional background of the experts.

To uncover the NRIs for stroke, traumatic brain damage, and whiplash, the same procedure as used for the identification of NRIs for brain damage in general was repeated. In Table 1, the joint results of these analyses are presented. Table 1 also shows which expert professions endorsed the item as an NRI if the first criterion (70% agreement over all raters, $n=40$) was not achieved, but if an inter-rater agreement percentage of at least

Table 1. Identified NRIs for different Patient groups by at least 70% of all experts (x), or by 70% or more in at least two specified Expert groups

Item	Brain damage, general	Stroke or CVA	Traumatic brain damage	Whiplash
003	Pr			Pr
010	x	Pr	Pr	Pr
018	Pn			
023	x	x		
031	x	Ppr	x	x
038	Pr		Pnr	
039	Pr			Pr
040	x			Pnr
045	Pr			Pr
053	x			Pr
057	x			x
091	pr	pr		
093	**x**		**Pr**	**Pr**
101	x			x
106	x	x	Pr	
116	**x**		**Pnr**	
141	Pr	Pr	Pr	Pr
146	x	x		
147	x	x	x	
149	x			x
152	Pr			Pr
164	x			x
165	x	x	x	Pnr
168	Pr		Pr	
173	Pr			
176	x		Pr	x
177	x	Pnp	Ppr	
179	x	Pr	Pr	
180	x	Ppr	x	
182	x	Pnr		
213	**x**		**x**	
224	Pr			Pr
229	Pnr	Pnr	Pr	
247	x	x	Ppr	
249	Pr			
252	Pr			
255	x			Ppr
295	x	x	Ppr	
299	Ppr	Pr	Ppr	
308	x	Pn	Pnr	
309	Pr	Pr	Pr	Pr
325	x	Ppr	x	Pr
341	x	x	x	Pr
404	Pr			
444	**Pr**			
464	x			Pr
472	x	x	x	Ppr
475	x	x	x	Pr
476	Pr			
525	x	x	x	Pr

Table 1. *Continued*

533	**x**	**x**	**Pr**	
536	**pr**			
561	Ppr			Pr
565	x	pr	x	Pr
n =	54	26	28	28

P = neuropsychologists; n = neurologists; p = psychiatrists; r = physiatrists.

Note. Bold items should be abandoned in the ultimate sets. See text for explanation.

70% for two expert professions was obtained. Thus, substantially different sets of NRIs are recognized for specified neurologic patient groups.

Further investigation revealed that 26 out of 42 MMPI-2 scales (62%) include NRIs, and that many NRIs contribute to more than one MMPI-2 scale (range 0–13). For example, item 165, 'My memory seems to be all right (false)' is included in the scales 2-D, 7-Pt, 8-Sc, and PS. See Table 2 for an overview of scales which include NRIs. This Table presents all NRI by scale combinations, if endorsed in the scored direction.

The following 16 MMPI-2 scales do not include NRIs: L, K, Mf, FRS, BIZ, CYN, ASP, TPA, SOD, FAM, TRT, O-H, Do, GM, GF, and AAS.

In the final stage, as a result of the above-described stepwise procedure, four sets of clinical relevant NRIs (in terms of influence on MMPI-2 scales) were selected for different neurological patient groups. Three items (116, 213, and 533, bold face type in Table 1) were excluded because of difficulties in asserting how such items influence the scales. Three other items (93, 444, and 536, bold face type in Table 1) were not included in the sets because, when scored in the displayed direction, they are not found in any of the current MMPI-2 scales. Thus, their endorsement would have no influence on scaled scores.

Discussion

As in earlier studies (e.g. Gass and Lawhorn, 1991; Gass and Russell, 1991; Alfano *et al.*, 1993), the findings of this study unveil MMPI-2 items which may indicate bona fide symptoms or manifestations related to neurological damage or dysfunction, rather than just reflecting psychopathology or personality disorders.

Effects over all 567 items, as well as item specific results, have been presented. With respect to the complete item pool, the results show that whether an arbitrary MMPI-2 item is considered to be neurologically relevant is dependent on the professional background of the expert as well as on the patient group. More items were seen as neurologically relevant by physiatrists and neuropsychologists in comparison to neurologists and psychiatrists. In addition, with respect to the 567 items of the MMPI-2, all expert professions identified more items as being neurologically relevant for brain damage in general than for stroke, traumatic brain damage, or whiplash.

The procedure followed in this study revealed four sets of NRIs: One for brain damage in general, and three partially overlapping sets for the specific patient groups. Thus, manifestations of neurologic dysfunction may alter MMPI-2 *T*-scores or profile configurations in a different way for distinct brain diseases.

With respect to the selection method utilized in this investigation, two indices were chosen to evaluate an item as a potential NRI. The first one was an inter-rater agreement

Table 2. Item contribution to MMPI-2 scales if endorsed in the scored direction (t

Item	F	1-Hs	2-D	3-Hy	4-Pd	6-Pa	7-Pt	8-Sc	9-Ma	0-Si	ANX	OBS
003		f		f			f					
010		f	f	f								
018	t	t	t	t								
023						t	t	t	t			
031			t	t	t		t	t		t	t	
038			t				t	t				
039		t	t	t							t	
040				t								
045		f	f	f								
053		t										
057		f										
091		f		f				f				
093												
101		t		t								
106								f	f	f		
116												
141		f	f	f								
146			t			t						
147			t				t	t				
149		t										
152		f		f								
164		f		f								
165			f				f	f				
168	t							t	t			
173		f		f								
176		f		f								

= true, f = false)

DEP	HEA	ANG	LSE	WRK	A	R	MAC-R	Es	Re	Mt	PK	PS	APS
f										f	f	f	
				f		f				f			
	t												
											t		
				t		t				t	t	t	
t									t			t	
											t		
	t												
	f					f						f	
	t												
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	f												
	t										t		
		t										t	
	f											f	
t													
										f			
t									f				
											f		
f													
												f	
				t						t	t	t	
f													

Item	F	1-Hs	2-D	3-Hy	4-Pd	6-Pa	7-Pt	8-Sc	9-Ma	0-Si	ANX	OBS
177								f				
179		f		f				f				
180	t							t				
182								t		t		
213												
224		f		f								
229								t		t		
247		t						t				
249		f		f								
252	t							t				
255		f				f		f		f		
295								f				
299								t			t	
308							t			t		
309							t					t
325							t	t				
341												
404												
444												
464												
472												
475												
476												
525												
533												
536												
561												
565												

DEP	HEA	ANG	LSE	WRK	A	R	MAC-R	Es	Re	Mt	PK	PS	APS
	f												
												t	
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	f												
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of at least 70% of all the experts (n = 40). This is consistent with the minimum levels of 67% inter-rater agreement in Taylor (1970), Alfano *et al.* (1990), and Gass and Russell (1991). The second index required an inter-rater agreement of at least 70% within two or three expert professions $n = 20$ or 30). The use of this second index was warranted because, although some items did not reach the 70% criterion when all expert professions were considered, these items represent well-known disabilities after brain damage, resulting from organically determined pathology or impairments. An example is item 224, which refers to pain. Although this item did not attain a 70%-rating, it is recognized that pain sensation as a primary consequence may be heightened to an overwhelming degree with some kinds of thalamic damage (Clifford, 1990) and as a secondary consequence after stroke accompanying a frozen shoulder (Davis *et al.*, 1977).

The differences found between the four expert professions, or omissions such as described above, are not always easy to understand. Although one should keep in mind that these differences do not pertain to individuals but to different groups of expert professionals, we suggest some tentative explanations. Many neurologists, for example, could be considered predominantly so-called 'organ specialists', fascinated by diseases of the brain and its impaired functions, whereas physiatrists and clinical neuropsychologists, predominantly working in rehabilitation, deal mainly with the long-term sequelae of diseases in terms of disabilities and handicaps. The psychiatric ratings may be explained by the reliance on diagnostic classification systems, such as the Diagnostic and Statistical Manual of Mental Disorders, that allow little leeway in describing the symptoms of brain-damaged patients in non-psychiatric terms. In addition, some items, such as item 141 ('During the past few years I have been well most of the time'), could possibly be included more often by physiatrists and neuropsychologists than by neurologists because the former are more likely to have seen a particular selection of neurologic patients, and they also see such patients at later stages in the aftermath of brain damage.

The differences between expert professions may, indeed, be further explained by the structure of the health care system in the Netherlands. The treatment approach which is oriented toward daily life problems may give rehabilitation professionals more opportunity to look at brain behaviour relations from many different points of view. There are for this two reasons. First, the amount of time spent with a selected group of brain-damaged patients (i.e. those referred for rehabilitation) may, on average, be considerably longer as compared to the length of the contact that a neurologist or a psychiatrist has with a brain-damaged patient. Secondly, patients following rehabilitation programmes can be observed in many different activities: physical exercises, ADL-activities, householding, communicative and social skills programmes, sports, cognitive remediation, community and job re-entry programmes, and so on. Therefore, experts working in rehabilitation might be in a better position to recognize certain symptoms or behavioural manifestations that are phrased in the MMPI-2 as possibly reflecting consequences of brain damage. Furthermore, such manifestations may be clinically latent in other situations and under other conditions.

In our opinion, no single discipline can adequately assess the consequences of brain dysfunction. The types of brain dysfunction being examined do not result in a steady and uniform set of neurobehavioural sequelae or symptoms. The 'model' patient encountered by each profession may have been the mostly likely target for item selection. Table 1 clearly shows that for different patient groups many NRIs would not have been selected if, for example, only neurologist's and psychiatrist's ratings had been included. Therefore, we

argue that the reliability of the selection is heightened by the use of ratings from the four main brain-behaviour professions working in the clinical neurosciences.

Although several items presented by others were not selected in our study, we consider the present results to be relevant. First, all NRIs in the Gass' studies that were not selected in this investigation, were considered as neurologically relevant by (far) less than 50% of the expert professionals. Item 47, for example, 'I am almost never bothered by pains over my heart or in my chest', was included by only 10% of the actual raters. Secondly, in this study, the complete MMPI-2 was included, which resulted in additional NRIs that were not, nor could not have been selected in the other studies. Thirdly, in rating NRIs, the number of consulted experts, and the professional roots of these experts differ substantially from earlier studies. For example, Gass and Russell (1991) considered an item to be relevant if two neurologists classified the item as appropriate for at least one out of four patients with head injury. The fact that only three specialists were consulted, does not sufficiently protect against personal preferences. Furthermore, the possibility of a high proportion of inter-rater agreement by chance needs to be considered. In this study, with 40 raters, this factor is negligible. Fourthly, the selection of NRIs is based on item content instead of on the discriminative power of individual items between a normative sample and patients, or on the endorsement frequency by groups of patients. That method was used, for example, by Alfano *et al.* (1993). Such a selection strategy is debatable for two reasons. The patient sample may be disproportionally heterogeneous, which will inevitably lead to a biased NRI selection. Moreover, even if the frequency of endorsement of potential NRIs does not differentiate patients from a normative sample, it should not be abandoned apriori. In our opinion, at last, clinical relevance of an item as an NRI should not be defined by frequency rates but by content. Even if the endorsement of an NRI is seldom, it still is an NRI. Fifthly, unlike earlier studies, in this investigation the variable 'expert profession' is constant for all patient groups. In addition, mean endorsement frequencies over all MMPI-2 items show that the expert professions give the same rank for the patient groups. Therefore, the results unambiguously reveal that the selected NRIs for circumscribed patient groups are primarily dependent on the type of brain damage and the accessibility to the profession of observing brain behaviour relations in a particular health care system.

This study was aimed at selecting NRIs within the MMPI-2 for brain damage in general, and for stroke, traumatic brain damage and whiplash in particular. Once selected, the question raised is how to appropriately correct for NRIs. Therefore, in a subsequent investigation, we will study the effects of endorsing NRIs on Scale-scores and on profile configurations for brain damaged patient groups. In addition, we intend to provide a neurocorrective approach based on the complete MMPI-2 item pool.

References

Alfano, D.P., Finlayson, M.A.J., Stearns, G.M. and Neilson, P.M. (1990). The MMPI and neurologic dysfunction: profile configuration and analysis. *The Clinical Neuropsychologist*, **4**, 69–79.

Alfano, D.P., Paniak, C.E. and Finlayson, M.A.J. (1993). The MMPI and closed head injury: a neurocorrective approach. *Neuropsychiatry, Neuropsychology and Behavioral Neurology*, **6**, 111–16.

Beck, A.T. (1987). *Beck Depression Inventory*. San Antonio, TX: The Psychological Corporation.

Butcher, J.N., Dahlstrom, W.G., Graham, J.T., Tellegen, A. and Kaemmer, B. (1989). *Minnesota Multiphasic Personality Inventory (MMPI-2): Manual for Administration and Scoring*. Minneapolis: University of Minnesota Press.

Chelune, G.J. and Moehle, K.A. (1986). Neuropsychological assessment and everyday functioning. In *The Neuropsychology Handbook: Behavioral and Clinical Perspectives* (edited by D. Wedding, A.M. Horton, Jr. and J. Webster), pp. 489–525. New York: Springer.

Clifford, D.B. (1990). The somatosensory system and pain. In *Neurobiology of Disease* (edited by A.L. Pearlman and R.C. Collins), pp. 86–100. New York: Oxford University Press.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational Psychology Measurement*, **20**, 37.

Coughlan, A.K. and Storey, P. (1988). The Wimbledon Self-report Scale: emotional and mood appraisal. *Clinical Rehabilitation*, **2**, 207–13.

Davis, S.W., Petrillo, C.R., Eichberg, R.D. and Chu, D.S. (1977). Shoulder-hand syndrome in a hemiplegic population: a 5-year retrospective study. *Archives of Physical Medicine and Rehabilitation*, **58**, 353–6.

Derksen, J.J.L., De Mey, H.R.A., Sloore, H. and Hellenbosch, G. (1995). *MMPI-2: Handleiding bij Afname, Scoring en Interpretatie* (2nd ed). Nijmegen: PEN Test Publisher.

Derogatis, L.R. (1983). *SCL-90-R: Administration, Scoring & Procedures Manual-II for the R(evised) Version*. Towson, Md: Clinical Psychometric Research.

Gass, C.S (1991). MMPI-2 interpretation and closed head injury: a correction factor. *Psychological assessment: A Journal of Consulting and Clinical Psychology*, **3**, 27–31.

Gass, C.S (1992). MMPI-2 interpretation of patients with cerebro-vascular disease: a correction factor. *Archives of Clinical Neuropsychology*, **7**, 17–27.

Gass, C.S and Lawhorn, L. (1991). Psychological adjustment following stroke: An MMPI study. *Psychological assessment: A Journal of Consulting and Clinical Psychology*, **3**, 628–33.

Gass, C.S and Russell, E.W. (1991). MMPI profiles of closed head trauma patients: impact of neurologic complaints. *Journal of Clinical Psychology*, **47**, 253–60.

Graham, J.R. (1993). *MMPI-2: Assessing Personality and Psychopathology* (2nd edn). New York: Oxford University Press.

Greene, R.L. (1991). *The MMPI-2/MMPI: An Interpretive Manual*. Boston: Allyn and Bacon.

Lezak, M.D. (1995). *Neuropsychological Assessment* (third rev. edn). Oxford: Oxford University Press.

Miller, L. (1996). Neuropsychology and pathophysiology of mild head injury and the posteoneussion syndrome: clinical and forensic considerations. *The Journal of Cognitive Rehabilitation*, **14**, 8–23.

Prigatano, G.P. (1987). Psychiatric aspects of head injury: problem areas and suggested guidelines for research. In *Neurobehavioral Recovery from Head Injury* (edited by H.S. Levin, J. Grafman and H.M. Eisenberg), pp. 215–31. New York: Oxford University Press.

Radanov, B.P. and Dvorak, J. (1996). Spine update. Impaired cognitive functioning after whiplash injury of the cervical spine. *Spine*, **21**, 392–97.

Sloore, H., Derksen, J.J.L., Hellenbosch, G. and De Mey, H.R.A. (1993). *MMPI-2. Vragenboekje. Vlaams-Nederlandse vertaling en bewerking*. Nijmegen: PEN Tests Publishers.

Sweeney, J.E. (1992). Nonimpact brain injury: grounds for clinical study of the neuropsychological effects of acceleration forces. *The Clinical Neuropsychologist*, **6**, 443–57.

Taylor, G. (1970). Moderator-variable effect of personality-test-item endorsements of physically disabled patients. *Journal of Consulting and Clinical Psychology*, **35**, 183–8.

Van Balen, H.G.G., Mulder, Th. and Keyser, A. (1996). Toward a disability oriented approach of traumatic brain injury. *Disability and Rehabilitation*, **18**, 181–90.

Woessner, R. and Caplan, B. (1995). Affective disorders following mild to moderate brain injury: Interpretive hazards of the SCL-90-R. *Journal of Head Trauma Rehabilitation*, **10**, 78–89.

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Appendix

Identified neurologically relevant items (NRIs) in the MMPI-2 for each item if endorsed in the scored direction (T = true, F = false)

003 I wake up fresh and rested most mornings (F).
010 I am about as able to work as I ever was (F).
018 I am troubled by attacks of nausea and vomiting (T).
023 At times I have fits of laughing and crying that I cannot control (T).
031 I find it hard to keep my mind on a task or job (T).
038 I have had periods of days, weeks, or months when I couldn't take care of things because I couldn't 'get going'. (T).
039 My sleep is fitful and disturbed (T).
040 Much of the time my head seems to hurt all over (T).
045 I am in just as good physical health as most of my friends (F).
053 Parts of my body often have feelings like burning, tingling, crawling, or like 'going to sleep' (T).
057 I hardly ever feel pain in the back of my neck (F).
091 I have little or no trouble with my muscles twitching or jumping (F).
093 Sometimes when I am not feeling well I am irritable (T).
101 Often I feel as if there is a tight band around my head (T).
106 My speech is the same as always (not faster or slower, no slurring or hoarseness) (F).
116 Often I can't understand why I have been so irritable and grouchy (T).
141 During the past few years I have been well most of the time (F).
146 I cry easily (T).
147 I cannot understand what I read as well as I used to (T).
149 The top of my head sometimes feels tender (T).
152 I do not tire quickly (F).
164 I seldom or never have dizzy spells (F).
165 My memory seems to be all right (F).
168 I have had periods in which I carried on activities without knowing later what I had been doing (T).
173 I can read a long time without tiring my eyes (F).
176 I have very few headaches (F).
177 My hands have not become clumsy or awkward (F).
179 I have had no difficulty in walking or keeping my balance (F).
180 There is something wrong with my mind (T).

182 I have had attacks in which I could not control my movements or speech but in which I knew what was going on around me (T).
213 I get mad easily and then get over it soon (T).
224 I have few or no pains (F).
229 I have had blank spells in which my activities were interrupted and I did not know what was going on around me (T).
247 I have numbness in one or more places on my skin (T).
249 My eyesight is as good as it has been for years (F).
252 Everything tastes the same (T).
255 I do not often notice my ears ringing or buzzing (F).
295 I have never been paralysed or had any unusual weakness of any of my muscles (F).
299 I cannot keep my mind on one thing (T).
308 I forget right away what people say to me (T).
309 I usually have to stop and think before I act even in small matters (T).
325 I have more trouble in concentrating than others seem to have (T).
341 At periods my mind seems to work more slowly than usual (T).
404 I have no trouble swallowing (F).
444 I am a high-strung person (T).
464 I feel tired a good deal of the time (T).
472 I am greatly bothered by forgetting where I put things (T).
475 Often I get confused and forgot what I want to say (T).
476 I am very awkward and clumsy (T).
525 Everything is going on too fast are around me (T).
533 I forget where I leave things (T).
536 If I get upset I'm sure to get a headache (T).
561 I usually have enough energy to do my work (F).
565 It takes a great deal of effort for me to remember what people tell me these days (T).

Note. Bold items should be abandoned in the ultimate sets. See text for explanation.